

## LIFE HISTORY NOTES ON THREE TROPICAL AMERICAN CUCKOOS

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THE cuckoos of tropical America are a most interesting group of birds, comprising brood parasites and species which breed communally, as well as some which nest as isolated pairs. Yet the only members of the family for which we have somewhat detailed life histories from the American tropics are the Smooth-billed Ani (*Crotophaga ani*) (Davis, 1940a), the Groove-billed Ani (*C. sulcirostris*) (Skutch, 1959), and the Guira Cuckoo (*Guira guira*) (Davis, 1940b). I have long had in my notes observations on the Squirrel Cuckoo (*Piaya cayana*) and the Lesser Ground-Cuckoo (*Morococcyx erythropygus*) which I have withheld from publication in the hope of rounding out my accounts by further studies. But nests of these birds are by no means easy to find—year after year I searched in vain for another nest of the widespread Squirrel Cuckoo—and it seems best to put on record such information as I have about these birds, without indefinite delay. Some long-unpublished observations on the Smooth-billed Ani also seems worthy of inclusion in this report.

### SQUIRREL CUCKOO

Cuckoos, at least the American species, are nearly all birds of pronounced character, easy to recognize by appearance or by voice. The Squirrel Cuckoo (*Piaya cayana*) is no exception. It is a fairly large bird, 16½ inches in length, nearly 11 of which are accounted for by its long tail. The upper plumage is rich chestnut, paler on the head, and deepening into bay on the tail, the strongly graduated feathers of which are broadly tipped with white and crossed by a broad subterminal band of brownish black. The chin, throat, and upper chest are vinaceous-cinnamon; the breast, abdomen, and sides plain gray, deepening into slate gray on the flanks and thighs and slate black on the undertail coverts. The undersurface of the tail is blackish, except for the white tips. The bill and naked region about the eyes are yellowish green; the big eyes deep red; the legs and feet light bluish gray. The sexes are alike in appearance.

The species occurs over the greater part of continental tropical America from central México to western Perú, northern Argentina, and Trinidad. In Central America, the Squirrel Cuckoo inhabits the wettest as well as the driest districts and ranges from sea level far up into the mountains. In Guatemala it has been found as high as 6,300 feet (Land, 1962:272). In Costa Rica I have met it at 6,300 feet in the Tablazo Mountains in November and at 7,300

feet on the excessively wet northern slopes of Volcán Irazú in the same month. At Vara Blanca, farther west in the same volcanic range, it did not appear to be resident even as high as 5,500 feet. Here I failed to see a single individual from July to the beginning of March, when a few arrived in the neighborhood of my dwelling and stayed for several months, probably breeding, although I found no nest. In México, the Squirrel Cuckoo extends upward to 7,800 feet (Friedmann et al., 1950:133); in the Coastal Range of Venezuela, to about 5,000 feet (Schäfer and Phelps, 1954:61). Nearly everywhere this cuckoo is most abundant at low altitudes, rare above 4,000 or 5,000 feet.

The Squirrel Cuckoo avoids unbroken forest and is at home in more or less open country with scattered trees. It inhabits cultivated districts in general, where it is particularly fond of hedgerows, coffee plantations with open shade, pastures and dooryards with well-spaced trees, and abandoned clearings where here and there a taller tree, almost overwhelmed by a heavy burden of creepers, has managed to struggle up above the disorderly welter of swiftly springing vegetation. It often hunts through the tangle of vines at the forest's edge and even the crowns of trees a short distance within the forest, but it consistently shuns the dark undergrowth. In semidesert regions, the Squirrel Cuckoo is most likely to be found among the taller trees along watercourses and in low ground.

I cannot recall ever having seen one of these birds undertake a sustained flight. Its journeys are short and it moves along from tree to tree and bough to bough, with now and then a swift dart across an open space. It prefers to gain altitude by working from limb to limb rather than by a single effort; but when it finds itself at last far up a hillside or high in the crown of a tree and wishes to return to lower levels, it sets its short wings and, with its great tail streaming, makes a long downward glide, uttering sharp metallic notes as it goes. Squirrel Cuckoos never flock but live in pairs at all seasons. The members of a pair do not as a rule keep close company either in flight or while hunting through the vegetation, but straggle along one behind the other, often several trees apart, keeping contact by means of their voices.

*Food.*—The Squirrel Cuckoo is, so far as I have seen, exclusively an insect-eater. It hunts among the trees, bushes, and tangles of vines in a fashion all its own, which combines deliberate motion and careful scrutiny with sudden darts and leaps of sometimes amazing length. Keeping itself usually well concealed by the foliage, it turns its head slowly from side to side and scans the surfaces of the leaves with wide, deep red eyes until it spies something to tempt it into activity. Then by a sudden pounce it makes the prey its own. A caterpillar crawling over the lower surface of a leaf above its head may cause the cuckoo to leap vertically upward for a distance of several feet.

When it has deftly seized its victim, it returns to a convenient perch, against which it may beat its prey into quiescence before gulping it down; or it may merely mash the morsel between its yellow-green mandibles. Then it sits quietly, or hops in a leisurely fashion from bough to bough, all the while scrutinizing the leafage until something else excites it to more vigorous action. Or it may shift its position by running with short hops or longer bounds along a horizontal or ascending limb, thereby earning for itself the name of *pájaro ardilla* or "squirrel bird."

One morning I watched a Squirrel Cuckoo capture a phasmid or walking-stick insect about four or five inches long. The insect was gray, with short wings, the under pair bright pink in color. It slipped from the bird's bill and fell to the ground, but the captor dropped down to recover it, carried it to a neighboring branch, and pounded it before swallowing it whole. According to Todd and Carriker (1922:212), the food of *Piaya columbiana*, which is sometimes considered conspecific with *P. cayana*, consists almost wholly of walking-stick insects, especially the larger kinds. But in Central America, Squirrel Cuckoos capture many insects of other sorts: a large proportion of them are green, and caterpillars enter prominently into the birds' fare. Moths are also eaten. With incredulous amazement, I have from time to time watched a Squirrel Cuckoo pluck a spiny green caterpillar from the foliage. Some of the most excruciating, long-continued pain I have ever suffered was caused by accidentally touching the venomous branched spines which cover all the upperparts of such caterpillars. Yet after mashing it somewhat in its bill, the cuckoo nonchalantly gobbles it down!

*Voice.*—The vocabulary of the Squirrel Cuckoo is surprisingly varied, so that for a number of years after I first made its acquaintance, I continued to discover new utterances, which mystified me until I traced them to this versatile bird. The call most often heard is a clearly enunciated trisyllable uttered in a dry and seemingly derisive voice. As I have heard it in Costa Rica and Panamá, this call is well paraphrased by the word *jícáro* (pronounced *híc-ă-ro*, the name of the calabash tree, *Crescentia cujete*). As I write this, I hear a cuckoo calling so in the dooryard. The sudden staccato first syllable and the somewhat lengthened final syllable alone are audible; the short middle syllable fails to carry so far. Cherrie (1916:313) recorded that in the Orinoco region the native name for the Squirrel Cuckoos is *piscua*, which would also be a good rendering of the call of the Central American birds if written with an accent on the final *a*, causing it to be pronounced *pees-coo-aáh*. This was evidently the call which Chapman (1929:62), writing of Squirrel Cuckoos on Barro Colorado Island in the Panamá Canal Zone, set down as a "dry *piscátaqua piscátaqua*"; but I have not been able to detect a fourth syllable in our local birds' utterance. In Honduras I wrote this call as *wheék wheeu*;

but at an interval of years I cannot be sure that my different paraphrase represents an actual variation in the language of the cuckoos at points so far separated as Costa Rica and the northern coast of Honduras. Although the *jícara* call is often loud and far-carrying, it may be given intimately in an undertone.

Another common utterance of the Squirrel Cuckoo is a loud and seemingly mocking dissyllable. *Eee-kah* I have written it in both Guatemala and Panamá. The final syllable may be long drawn out. This is doubtless the utterance referred to by Chapman as a "little staccato crow, *chick-kaw*, one of the most characteristic of tropical bird-notes." It is probably this call or its equivalent which Sutton and Pettingill (1942:15) heard far north in México and described as "an imperative *creep-rear* or *keep-rear*, like one of the Derby [Kiskadee] Flycatcher's cries, but louder."

Another very different utterance, heard chiefly in the breeding season, consists of a monosyllable repeated many times over in measured cadence: *whip—whip—whip—whip . . .*; or sometimes the note has sounded more like *wic*. It may be either loud and sharp or low and soft; or the opening notes in the series may be loud and clear, while succeeding ones become weaker until the last are faint and squeaky. I have heard this utterance throughout the length of Central America; it is probably this which Sutton and Pettingill heard in México and wrote as "a loud *kweep, kweep, kweep, kweep*," rightly suggesting that it was in the nature of a song.

Quite different again, and not so often heard, is the Squirrel Cuckoo's long-drawn churr or rattle, delivered with the bill widely open and the lower mandible vibrating. Then there is a single, sharp, staccato *peek*. While making a long downward glide on set wings, the cuckoo utters a series of loud, sharp, metallic monosyllables—a somewhat hawk-like note which perhaps ensures a degree of safety to the weakly flying cuckoo during the brief period when it exposes itself beneath the open sky, by making it seem what it is not.

*Courtship*.—Over the years, I have from time to time seen a Squirrel Cuckoo present an insect or caterpillar to its mate. Early on the sunny morning of 13 April 1944, while watching the birds of many kinds which swarmed among the shade trees of my small coffee grove, my attention was drawn by a cuckoo who bounded along a branch in characteristic fashion, holding in his bill a green insect of moderate size. He presented this to his mate, and as she grasped it, he mounted upon her back. Continuing to hold onto the insect at the same time as she, he rested on her for the better part of a minute. Then he attempted the nuptial embrace, leaning far over sideways and crossing his long tail beneath hers. The size of his tail made it necessary for him to lean much farther out to the side than most small birds do in coition. The grasp which both members of the pair had all this time on the insect apparently



gave him essential support; without it, he must have had much difficulty in maintaining his balance as he bent his tail beneath that of his mate.

A little later, my eyes caught this pair of Squirrel Cuckoos as they perched side by side on a horizontal bough, tugging at a green caterpillar, which was stretched far out between them. Finally, it broke under the strain, with the lion's share remaining with the male, while the female retained and at length swallowed only a tiny end. A minute later, I learned the manner in which this tug-of-war had probably originated. The male found another green insect and offered it to the female, at the same time attempting to mount upon her back. But she was not ready for more of this and sidled away from him, this time carrying off all the prize, which she swallowed. In Africa, a male Emerald Cuckoo (*Chrysococcyx cupreus*) presented a large hairy caterpillar to a female, displayed, then mounted her (Haydock, 1950). Friedmann (1956: 405) believed that the feeding of young by the parasitic Didric Cuckoo (*Chalcites caprius*) results from the cock's failure to distinguish grown fledglings from females of his species.

*Nest building.*—I have seen only four occupied nests of the Squirrel Cuckoo, and in addition I have watched two pairs working at structures that were not used. The sites chosen for these nests differed so greatly that I shall describe each of them. The first occupied nest was in the basin of El General, Costa Rica, at an altitude of 3,000 feet. It was eight feet above the ground in a dense hedge of lemon trees that separated a pasture from a roadway used by many horsemen and pedestrians. Here it rested on horizontal vines and branches, well screened from the road by foliage. The next three nests were on our farm at Quizarrá in the basin of El General, at an altitude of about 2,500 feet. One of these, on a sterile hillside which the preceding year had been sown with maize, was only 30 inches above the ground in a tangle of tall bracken fern (*Pteridium aquilinum*) and the straggling composite *Eupatorium vitalbae*. Another occupied nest was in a bushy abandoned pasture, where, at a height of 39 inches, it was supported by a tangle of bracken, the same straggling composite, and calingüero grass (*Melinis minutiflora*). Close by grew a small bush of *Piper* that gave the nest a little shade.

After the premature loss of the eggs that this nest held, 19 years passed before I noticed another nest of the Squirrel Cuckoo on this farm. On the surprisingly early date of 14 January 1966, after 10 rainy days had followed a dry interval at the turn of the year, I found a pair building in the top of an orange tree near our house. Their site was about 25 feet above the ground in a tangle of slender dead vines amid clustered foliage and ripe fruits. The birds brought a number of sticks and leaves but, as far as we could learn, they never laid here. On 22 January, I watched a pair of cuckoos, evidently the same, completing a nest in a clump of tall timber bamboos, about 300 feet

from the orange tree. Situated about 40 feet up on an arching spray, amid crowded twigs and leaves, this latest structure was difficult to see from the ground and quite inaccessible to a human climber. But it was in sight of my study window and afforded the best series of observations I have made on the breeding of this elusive cuckoo.

Another nest site differed greatly from all the foregoing and was hardly typical—certainly it did not furnish the cuckoos with the kind of foundation they needed to support their loose accumulation of sticks and leaves. On 21 May 1935, Miss Helena Emerson called my attention to a pair of Squirrel Cuckoos who were carrying material into the crown of the large mango tree that grew behind the main building in the narrow clearing in the forest on Barro Colorado Island. She said that she had seen only one member of the pair fly back and forth carrying sticks into the tree, while the other remained concealed amidst the foliage. I hunted carefully in the treetop without finding a trace of a nest. Next morning I resumed my search, with similarly disappointing results. But later in the day I found the cuckoos at work. They had no sign of a nest; but one member of the pair perched on a twig, 40 feet up in the treetop, which apparently had been chosen as the nest site, while the mate fetched material. The active bird brought, in mixed order, long fine twigs broken from neighboring trees, and dead leaves chiefly from the mango tree itself, and passed these contributions to the partner who remained on the perch. The latter stuck them beneath her, whence they promptly fell to the ground, for the single limb offered no adequate support. The ground beneath the mango tree was soon littered with these wasted twigs. It was difficult to follow the movements of the cuckoos, for they were trying to build in the very top of the tree, whose abundant dark foliage screened them from view. I could not make sure that the same bird always brought material while the other did nothing but sit and arrange it—which in this particular instance consisted in dropping it to the ground. Doubtless, however, this division of labor was regularly followed; and by analogy with anis which I have watched build their nests, and with pigeons, I suppose that it was the male cuckoo who brought the building materials, while the female received and disposed of them. While working in the mango tree, this pair called *ick-a-yuc* or *jícaro*, the loud derisive *eee-kah*, and frequently the low, soft *whip—whip—whip—whip* . . . in measured cadence; and once I heard the long-drawn churr or rattle.

For a week, these cuckoos labored to build a nest in the top of the mango, but after so much work they had nothing to show but an increasing litter of dead twigs on the ground beneath the tree. The supposed male tirelessly carried sticks and dead leaves to his mate, and she continued conscientiously to drop them as fast as received. Each day she had a definite perch where she

accepted them—the point where, no doubt, she fondly imagined that she could build a nest—but the place was changed two or three times in the course of the week. If she happened to be in another part of the tree when the male approached with a contribution for her projected nest, she hopped through the branches to her most recently chosen site, took the object from his bill, tucked it carefully beneath herself—and dropped it to the ground. Possibly she was a young cuckoo attempting to make her first nest, and learning by dearly bought experience that a Squirrel Cuckoo's nest requires fine, close-set branches as its foundation—not coarse, widely separated twigs, as in a mango tree.

At about five o'clock on the evening of 28 May, the female cuckoo laid an egg while perching on the twig from which she had most recently been dropping material intended for a nest. Quite naturally, the egg followed the nest materials to the ground and came to rest among them—where should an egg lie but on such materials? It broke with its fall, and I had an opportunity to examine, inside and out, my first egg of *Piaya*. A week earlier I had found another white egg which reached the ground beneath the mango tree with only a slight hole in one side. I had suspected that this had been laid by the cuckoo but was not certain of this until I could compare it with the egg dropped in my presence.

After the cuckoos had been building in this hopeless fashion for at least five days, I made a basket-like framework by tying forked twigs together, and fastened this in the top of the mango tree, where the birds had apparently determined to have their nest at any cost. If the cuckoos deigned to use this ready-made foundation, I thought that they had a fair chance of completing a nest. For several days they neglected it. But when I returned from the forest on the evening of 31 May, one of the guests at the laboratory told me that during the day she had seen one member of the pair sitting in my framework, while the mate brought sticks, which the former placed upon it. But even this foundation was too open to be successfully used by a bird so unskilled as the female cuckoo: most of the sticks that she laid in it slipped through the meshes and fell to the ground, with the result that next morning only two remained in position. To give these hard-working but inept birds a little better start, I picked up a handful of twigs that they had dropped and, interlacing them in the framework, made them stay. Later in the day, the cuckoos came and added twigs and dead leaves, until by evening they had made quite a respectable beginning of their nest. To my regret, my busy sojourn on Barro Colorado ended next day; but I like to believe that the cuckoos completed the nest that I had started for them in the mango tree, and brought up a family there.

These cuckoos did not, like so many building birds, work most actively in

the early morning. They built—or tried to—chiefly during the latter half of the forenoon, and returned to their task at intervals through much of the afternoon, sometimes continuing to carry sticks until 1630. In their greater activity during the middle half of the day, they resembled their relatives, the anis.

The pair which built in the orange tree in January brought many green and yellowing leaves, some of which were plucked from nearby guava trees. They also took to the nest a small twig with several green leaves attached to it, and at least one dead twig. When this pair transferred their operations to the bamboo clump, they broke coarse dead twigs from neighboring trees and took them to the nest, one at a time. As far as I have seen, the Squirrel Cuckoo does not descend to the ground for building materials, but collects all it needs in the trees.

The completed nests of the Squirrel Cuckoo that I have seen in Costa Rica had a loose foundation or framework of long, coarse, straight, inflexible twigs. Upon or within this was piled a great mass of whole leaves, some brown and others green when the nest was newly built. Mixed with the leaves in the middle and upper portions of the nest were, in one instance, a few fine twiglets. The top of the nest is best described as a shallowly concave platform. One nest was about 7 inches in diameter (not including the projecting ends of the long twigs) and  $2\frac{1}{2}$  inches thick or high. The central mass of another nest was 6 or 7 inches in diameter by  $4\frac{1}{2}$  inches in height. The diameter of the shallow depression in the top was about  $3\frac{1}{2}$  inches.

*The eggs.*—Two of my Costa Rican nests contained two eggs each, and close by the third nest were two fledglings, which the children who found this nest told me had left that same day. Cherrie (1892:326) likewise recorded a nest with two eggs in Costa Rica. The Squirrel Cuckoo's eggs are pure white, with a somewhat rough and chalky surface. In shape they are ellipsoidal, with scarcely any difference between the two ends. Those of my first set measured 34.9 by 26.2 and 36.5 by 25.4 mm; of the second, 34.9 by 26.2 and 34.1 by 25.8 mm. Cherrie gave the measurements of eggs as 35 by 24 and 33 by 24 mm.

In El General, the Squirrel Cuckoo has a long breeding season. At the earliest nest, incubation began in late January of 1966. Two nests held eggs in April, and from another the nestlings left in early June. This cuckoo seems to nest chiefly from April to June, which is the main breeding period for the majority of the birds of this region. But on 20 October 1965 I found parents feeding a stubby-tailed fledgling in a treetop in our dooryard. They were probably the same pair that nested in the bamboo in the following January. Dr. John Emlen told me that, on the northern coast of Honduras, he had seen a Squirrel Cuckoo feed a fledgling as late as 5 September 1930.

Todd and Carriker (1922:212) recorded a set of three eggs of *Piaya columbiana* taken at Bonda, Colombia, on 10 July. They described the nest as "a frail platform of coarse twigs, without special lining, placed in the fork of an oblique branch of a *Banisteria laurifolia*, and so thin that it would easily be possible to count the eggs from below." If this nest, in its thinness and the absence of leaves differing greatly from those of the Central American Squirrel Cuckoo, is typical of *P. columbiana*, it furnishes an additional reason for considering this form to be specifically distinct from *P. cayana*.

*Incubation.*—Within a day or two after being laid, the immaculate white surface of the eggs becomes stained with brown from contact with the green leaves on which they rest. The heaviness of the staining increases from day to day, and long-incubated eggs are mottled with deep stains of brown. May not the function of the leaves be to cause these stains which mask the glaring whiteness that makes newly laid eggs so conspicuous in their shallow, open nest? By this device the cuckoos compensate for the failure of their oviduct to secrete pigment for the shell. They bring a few additional green leaves from time to time until the nestlings hatch. Meanwhile, small ants take shelter between the layered leaves which form most of the nest's bulk, and establish thriving colonies beneath the incubating birds.

The great tail of the incubating Squirrel Cuckoo, held tilted upward at a sharp angle, is a conspicuous object. Usually the bird sits steadfastly and permits a close approach by man, sometimes even permitting him to touch the tip of its long tail before it jumps from the nest. Then it may perch close by and twitch its head in a most peculiar fashion, while it watches the intruder. I have never known a Squirrel Cuckoo to protest my visit to its nest by voice or any more vigorous demonstration; it flies a good way off before calling to its mate. One cuckoo continued to cover its eggs while it watched me set a blind five or six yards away, an operation which necessitated cutting a certain amount of vegetation. I was confident that I should have no difficulty studying the mode of incubation at this nest; but for all its staunchness while attending its eggs, the cuckoo is canny. Stealing away without putting the bird from its nest, I left the blind in place the greater part of that day and through the following night. But when I returned at dawn with high anticipations of passing an interesting day and learning things I had long wanted to know about the elusive Squirrel Cuckoo, I found to my dismay that the eggs were unattended, cold, and wet. The birds had not resumed incubation by nine o'clock, when I removed the blind. Next day the eggs had vanished, apparently taken by some predatory animal. At the other nest with eggs, where I touched the tail of the sitting cuckoo, the density of the stand of bracken fern made it necessary to place my blind very close and to disturb



the surrounding vegetation more than I liked. The birds stayed from their eggs as long as the blind was present, but returned after it was removed.

Accordingly, it was not until many years later, after this paper had been accepted for publication, that at the high nest in the bamboo I succeeded in learning some of the details of incubation. Although the body of the sitting cuckoo was invisible from the ground, its long tail often revealed its presence. On the evening of 22 January, the day when I found the pair actively building here, one of them was on the nest, where it remained through the night. On 23, 24, and 25 January, I frequently saw a cuckoo sitting; but sometimes, if present, it was invisible because its tail projected on the far side of the nest. On 26 January, I watched continuously from dawn until nightfall. The parent who passed the night on the nest stayed until replaced by its mate at 0650. The latter then sat continuously for six hours and 23 minutes, or until 1313, when it silently left. After only 12 minutes of neglect, the eggs were covered, at 1325, by one member of the pair. Now began a period of restlessness, the two partners replacing each other at 1327, 1329, 1433, and 1529. At all but the last of these changeovers, the returning partner brought a stick or a green leaf to the nest. The bird who went to the eggs at 1529 sat continuously until it grew dark.

I also watched this nest through the whole of 28 January and from day-break until late in the afternoon of 30 January. From these observations it appears that, after the routine of incubation is well established, the two partners exchange places only twice each day and keep their eggs continuously attended. On 28 January the changeovers occurred at 0746 and 1535, so that the day shift lasted seven hours and 49 minutes. On 30 January, the changeovers were made at 0901 and 1612, and the day shift continued for seven hours and 11 minutes. The partner who went on the nest in the afternoon stayed at its post until relieved by its mate next morning. I could not tell whether the cuckoo who incubated through the night was the female or, as in the anis and some other members of the family, the male.

Sometimes the partner arriving to begin its long spell of incubation brought a leaf or a stick, but at other times it came with empty bill. The changeover was effected in silence, or with the utterance of a low *jicaro*. Although mostly it incubated silently, occasionally the sitting bird would call softly *whip whip whip* . . . , at the same time twitching its long tail feathers. These calls were especially likely to be heard as the time for its relief approached. Rarely the cuckoo rose from its eggs to hop around the nest and resettle on it facing in a different direction.

At the low nest found in April of 1943, both eggs were pipped 18 days after the second had been laid. Next day both shells had been pierced by the bills of the chicks trying to escape. Then the eggs were inexplicably deserted and

never hatched. These observations would make the period of incubation about 19 days, but possibly it was somewhat lengthened by the disturbances caused by my unsuccessful attempt to use the blind and by the daily passage of laborers along a path close by the nest.

*The nestlings.*—After the desertion of these eggs on the point of hatching, ants entered through the perforation in the shell and killed the chicks within, if they had not already died from exposure. I opened an egg and found that the dead embryo's blackish skin bore sparsely scattered, hair-like down feathers. Similar natal down is present in cuckoos of the genus *Coccyzus*, but anis (*Crotophaga*) are quite naked when they hatch.

I did not learn just when the eggs hatched at the high nest in the bamboo, but by 13 February the parents were bringing food to it. In the first 5¼ hours of the morning, they came only four times, on each visit bringing a single massive insect. This regimen of infrequent but surprisingly large meals was maintained so long as the young remained in the nest. After another week, I frequently saw a single feathered nestling as it stood up to flap its wings or rested on the nest's rim, never two, although two nestlings may have been present at the beginning. From 0545 to 1100 on 19 February, this nestling was fed only four times, by both parents; and during the morning of the following day it received five meals. The winged or larval insects were usually green but sometimes of a darker color and were often badly mangled when the parent arrived with them. One meal consisted of a large green caterpillar bristling with stinging spines. After it was feathered, the nestling flapped its wings vigorously while taking its food on or beside the nest. Its open mouth revealed a bright red interior. Occasionally, after delivering food, the parent carried away a dropping.

I first glimpsed the nestling when it rose up to receive a meal on the morning of 19 February. It was already well feathered, with conspicuous white tips on its short tail feathers. Nevertheless, the parents continued to brood it much, through the night and in the morning until well after sunrise, in the late afternoon, and whenever it rained. On the showery afternoon of 21 February, I saw a parent brooding for the last time. The following day the young bird was out of the nest.

In contrast to many other birds, the young Squirrel Cuckoo's separation from its nest was a gradual process. As early as 19 February, it sometimes rested beside rather than in its nest, or hopped rapidly around or over it, amid the close-set bamboo twigs. While perching on the rim, it spent many minutes assiduously preening and scratching; then it would settle down in the nest where I could not see it. By 22 February it seemed to be spending most of the day perching or hopping amid the crowded bamboo shoots near its nest, to which from time to time it returned. When it was out of sight, I could not

tell whether it had wandered farther off or was resting inside the nest. After it had spent two days in this manner, it moved away.

The fledglings that I saw close by the nest in the lemon tree that they had just left rather closely resembled their parents in plumage, but their tails were still rudimentary. Their eyes were brown instead of red as in the adults, their bills grayish horn-color, and the bare orbital region gray instead of yellowish green. At intervals these young cuckoos called out *eee-ka* very sharply. Their parents remained prudently out of sight while I was present. The nest and its surroundings were only slightly soiled by the droppings of the young cuckoos who had so recently left it, but this may have been in part a result of washing by the torrential rains of that period. The wet leaves in the lower part of the nest swarmed with ants, a variety of insect larvae, and other small creatures.

#### LESSER GROUND-CUCKOO

The Lesser Ground-Cuckoo (*Morococcyx erythropygus*) is a slender bird about 10 inches long. The general tone of its upper plumage, including the wings and tail, is brown, with bronzy and greenish reflections on the long central rectrices. The under plumage, from the chin and sides of the neck to the abdomen, is tawny-rufous. Each dark eye is surrounded by a yellow orbital ring, in front of which is a triangular area of bare yellow skin, while behind it is a similar area of bright blue skin. Each eye with its surrounding areas of featherless skin is enclosed by two black lines, which diverge from the base of the bill, curve over and under the bare patches, and meet again near the ear. To complete the striking color pattern of this bird, the rather slender bill is yellow, with a blackish band along its strongly downcurved culmen, and the legs and toes are bright orange-tawny.

One of the typical members of the Arid Tropical Avifauna of México and Central America, the Lesser Ground-Cuckoo ranges from the Mexican state of Sinaloa to northwestern Costa Rica. On the Pacific Coast, from the mouth of the Gulf of Nicoya northward, its distribution seems to be fairly continuous, but on the rainier Caribbean side of Central America it is largely confined to deep valleys, such as the middle reach of the Río Motagua in Guatemala, where enclosing mountain barriers intercept the rain-bearing winds and arid conditions prevail. In altitude, the ground-cuckoo ranges from sea level up to 4,000 feet in México (Friedmann et al., 1950:135) and somewhat less in Costa Rica. In this country, it is most abundant in the lowlands of Guanacaste and about the Gulf of Nicoya, where the dry season is long and severe. In the driest parts of its range, as in the Motagua Valley, the ground-cuckoo lives among cacti and sparse thorny scrub; in regions of heavier vegetation, it lurks in low dense thickets, such as occur on abandoned patches of cultivation, neglected pastures, and in the more open parts of light woodland. I have

even found it in thorny thickets just inland from the beach and at the edge of a mangrove swamp.

*Habits and voice.*—While I stood watching a pair of Rufous-naped Wrens (*Campylorhynchus rufinucha*) building their nest in a thorny *Pereskia* tree in the arid Motagua Valley on 15 July 1932, I heard a low, weak whistle, repeated again and again. Tracing the notes to their source, I spied a bird of unique aspect walking over the ground beneath the spreading, orange-flowered tree. By its slender form, long tail, bare skin around the eyes, and curved bill, I at once recognized this bird, new to me, as a cuckoo, a conclusion which was strengthened later, when it flew up to a perch and I noticed that two toes on each foot were directed backward. The cuckoo walked sedately over the patches of bare ground between the low, scattered bushes, picking up whatever it could find to eat, and once it jumped several feet straight into the air, to snatch some insect from the foliage. At intervals the bird paused and, raising its head, uttered a low, mellow whistle that seemed to come from far away, although I was not 20 feet from it. When calling, it hardly opened its bill. From the distance came a faint answering whistle. Not in the least shy in my presence, the cuckoo continued to forage with no sign of constraint while I watched, fully exposed to its view, only six or eight yards away.

After a while, the cuckoo jumped into some bushes, where it rested a few minutes before it descended to the ground on the other side and began to toy with some fallen twigs. Finally it selected some very fine ones and walked away with them in its bill. I was elated by the prospect of finding a nest of this new bird still under construction, but it dropped its burden before it disappeared among low bushes. Disappointed, I followed through the shrubbery until, from a low bush on my left, a bird burst forth so suddenly that I had only a fleeting glimpse of it. Peering into the shrub, I found a nest.

The Lesser Ground-Cuckoo has other notes which I did not hear from this bird in the Motagua Valley. At the edge of a low, dense thicket on the Peninsula of Nicoya, a cuckoo perched a few feet above the ground while it tirelessly repeated a full, rather deep, pensive whistle. Then it delivered a high, clear, stirring, trilled whistle, clacking its mandibles together while it emitted the notes.

*Nest and eggs.*—The nest to which I was led by the first Lesser Ground-Cuckoo that I ever saw was situated on the ground, well concealed beneath a low, densely branched shrub rounded by browsing cattle, beside a dry water-course in a pasture. It was a shallow bowl, loosely made of dry petioles and fine sticks, and lined with fine herbaceous materials, mostly in short lengths. The inside of the bowl was  $3\frac{1}{4}$  inches in diameter by  $1\frac{3}{4}$  inches deep. There were two white eggs with a chalky surface that could be scratched off by a fingernail. These eggs measured 27.0 by 20.6 and 27.8 by 21.0 mm. This



nest, discovered near El Rancho in the Motagua Valley of Guatemala, elevation 900 feet, on 15 July 1932, is the only nest of the Lesser Ground-Cuckoo that I have seen, or of which I have found a record.

*Incubation.*—The chalky eggs in the crudely constructed receptacle left no doubt that I had found a cuckoo's nest; but I had had only the most fleeting glimpse of the bird that I had frightened from it, so to confirm the identification I returned cautiously a quarter of an hour later. A ground-cuckoo was covering the eggs, where it remained steadfastly while I bent over it for a closer view. Then the bird ran rapidly from the nest; but after going only three yards, it abruptly slowed down and walked deliberately away, as though with a painful effort. On a fallen log five or six yards from me, the cuckoo paused, to remain quietly while I wrote a description of the nest and measured the eggs.

When I revisited the nest in the afternoon, the incubating parent did not leave until my inclined head was almost above it. This time it walked away even more deliberately than before, with little mincing steps, until it reached a bare, sandy area beneath an organ cactus. Here it stopped, puffed out its contour feathers to make itself look bigger, relaxed its wings, depressed its fanned-out tail, and moved back and forth several times with short, slow steps. Although it did not grovel, beating the ground with its wings in a typical act of injury simulation, it was clearly trying to lure me from its nest by a distraction display. When I approached, it slowly retreated beneath some bushes and passed beyond view.

A few days later, a parent (whether the same or not, I could not tell) gave a somewhat different display after leaving the nest when I came close. This time it walked deliberately away for several yards, then, still in full view, crouched on the ground with fluffed-out plumage and spread, depressed tail. In this attitude it vibrated its relaxed wings, beating them against its own body rather than the ground, which it seemed to scratch with its feet. When I followed, the cuckoo moved off until out of sight. On another occasion, the cuckoo left the nest, as I approached, by jumping two feet into the air, then alighted on the ground and walked away.

Since I had not succeeded in distinguishing the two parents by their appearance, I tried to mark one of them before starting to study their mode of incubation. Using a method that I had employed successfully with Groove-billed Anis, I covered the end of a short twig with cotton, soaked the cotton in white enamel, and stuck this improvised paintbrush into the nest, with its end projecting over the eggs. When I returned 15 minutes later, I found that my brush had been carried away, doubtless by the cuckoo who was now sitting on the eggs with no visible spot of white on its plumage. A second attempt to mark a parent by the same procedure was similarly unsuccessful. The



cuckoos sat so closely that I thought I might touch their backs with a wad of paint-soaked cotton on the end of a long, slender stick; but while the approaching object was still six inches away, the bird jumped from the nest and fled. Later I discovered that, while removing the short paintbrush, one of the parents had acquired a white mark at the base of its bill. I designated this bird as "A" and its mate as "B." I was eager to learn whether, as in anis, the male took charge of the nest through the night, but I was uncertain how I could determine the sexes of A and B without watching one of them lay an egg for a subsequent brood. In this manner, I have learned the sexes of several Groove-billed and Smooth-billed anis.

Having placed a distinguishing mark on one of the parent ground-cuckoos and set my blind before their nests, I watched continuously from 0700 to 1412 on 16 July. Cuckoo A, who had left the nest as I entered the blind, returned at 0743. At 0930, it turned the eggs and shifted its position, very slightly, for the first time in nearly two hours. When a half-grown calf walked within a yard of the nest, the incubating bird sat firmly. At 1015, it began to whistle, the notes at first very low but gradually becoming louder. At intervals its mate answered from the distance, and after a while these whistles sounded nearer. At 1024, B approached from the bushes to my left, flying low across the arroyo beside which the nest was situated. The newcomer alighted several feet from the nest, its bill full of fine material for the structure, and A left. Cuckoo B continued to approach the nest by walking, but when about two feet distant it seemed to suspect the blind, turned around, and marched away. But at 1041 B returned afoot, now with empty bill, and covered the eggs.

Cuckoo A had incubated continuously for two hours and 41 minutes when B arrived to replace it. Cuckoo B now sat for three hours and 26 minutes, never shifting its position nor turning the eggs in all this long interval. In the early afternoon, when the sun's nearly vertical rays reached the bird through the branches of the sheltering bush, it panted with open bill. Finally, at 1407, B deliberately arose, walked from the nest, and after proceeding a few steps called to its mate, whose voice had for some minutes been sounding in the distance. At 1412 A arrived, marching over the ground with a billful of fine material, which it added to the nest's lining. When the newcomer was comfortably settled on the eggs, I left.

My observations on this nest were interrupted by a bout of fever, which for parts of the next two days kept me in bed. The day after I resumed my study, the eggs vanished from the nest, leaving only a broken shell on the bare sand a few feet away. Before this tragedy occurred, I had learned that cuckoo A, who sat more steadfastly than B, passed each night on the nest. Apparently, incubation followed a simple schedule, A being in charge of the

eggs most of the time, while B took a turn of three hours or more in the middle of the day. From my experience with anis, I had little doubt that A, the more devoted parent, was the male. But the loss of the nest, and the continuing fever which drove me up into the more healthful highlands a few days later, prevented the confirmation of these preliminary conclusions.

#### SMOOTH-BILLED ANI

The Smooth-billed Ani (*Crotophaga ani*), a long-tailed black bird with a high-arched, laterally compressed bill, has so often been figured and described that it hardly needs an introduction to the readers of this paper. In contrast to the two foregoing cuckoos, about whose breeding little or nothing has been published, this bird of strange appearance and curious communal nesting habits has, over a period of nearly two centuries, acquired a fairly voluminous literature, much of which is based on casual and uncritical observations. One of the best of the early histories of the ani is that of Gosse (1847). Recorded information on the habits of the ani up to 1939 is well summarized by Bent (1940); and at about the same time, Davis (1940a) published the most complete study of the life history of this species that has come to my attention. His field work was done in Cuba. Since on the mainland of tropical America the Smooth-billed Ani has been less thoroughly studied, it seems proper to put on record observations which I made on a small colony on Barro Colorado Island in 1935—the same colony whose fortunes Chapman (1938) followed, chiefly during the two ensuing years. A concluding section deals with the range expansion of the Smooth-billed Ani in southern Costa Rica during the last quarter-century.

*The colony on Barro Colorado.*—On a brief visit to Barro Colorado Island on 8 and 9 June 1929, I found a nest of the Smooth-billed Ani, with three nestlings about five days old, in the clearing in front of the main building. When I next visited the island in December of 1930 and January of 1931, four anis dwelt in this clearing, which was several acres in extent, bordered on three sides by forest into which the anis never ventured far, and on the fourth by a wide expanse of the open water of Gatún Lake, across which they were never seen to fly. Hemmed in between the woodland and the water, this small colony was rather effectively isolated. It seemed barely to maintain itself in an environment which subsequent experience showed to be far from favorable.

When I returned to Barro Colorado on 6 February 1935, three anis were present in the clearing. Dr. Frank M. Chapman told me that earlier in the year there had been four. On 1 February he had found a nest, situated six feet above the ground in a small orange tree growing on the steep grassy slope of the banana plantation, above the shore of the cove in front of the main building. It then contained two eggs, but the birds were bringing additional

material and building up the structure. Chapman kindly placed this nest at my disposal for study. When I first saw it on 7 February, it was a roomy open cup, built largely of interlaced coarse twigs, and lined with leaves, many of which were still green—a typical anis' nest. It contained only three eggs, but later I noticed beneath the orange tree four eggs which had evidently been laid before I came and had somehow fallen from the nest. On 13 February the last egg was laid in this nest, which then contained nine eggs, which with the four on the ground made 13 that had been laid here.

These eggs were of the familiar ani type, oval or elliptical-oval in shape, with a pale blue or blue-green shell covered by a chalky white deposit that was easily scratched off and became darkly stained from contact with the withering leaves on which the eggs rested. The four fallen eggs were unbroken. When opened, one at least contained a small embryo, whose heart was beating after it had lain at least five days on the ground, demonstrating remarkable resistance to exposure. The number of eggs in and beneath the nest convinced me that two females had been laying. Since some of the eggs were fertile, a male must have been present. Hence I concluded that the group attending this nest consisted of two females and a male. Subsequent observations proved this assumption to be correct.

It seemed desirable to mark these anis in order to distinguish them individually. This was before the days of mist nets and all the methods that can be used for marking birds when one has them in his hand. Since I could not catch the anis, I stuck into the nest a little stick whose end, projecting over the eggs, bore a bit of cotton soaked in white enamel. I left it there much of the morning, replenishing the paint from time to time. All the anis rubbed against it and acquired white marks, but in varying degrees. All had pulled or bitten the cotton in an effort to remove it from the nest, as revealed by the paint on their black bills, but they did not succeed in carrying it away. At noon I took away the offending object.

One of the anis was well bedaubed with white on its crown, face, neck, and body. When I saw that this bird, who evidently had made the greatest efforts to remove the paintbrush, also took charge of the eggs through the night, I called him "Whiteface," the name I had given to a male Groove-billed Ani whom some years earlier I had marked in similar fashion. This earlier Whiteface had also incubated by night, and was more valiant than his mate in defending the nest. The present Whiteface was so extensively whitened that numerous other epithets having reference to this color would have been equally appropriate. His two partners were dubbed "Whitethroat" and "Whitebrow" from the marks they had acquired. I surmised that they were females, and at a later nesting proved this by watching them lay.

*Incubation.*—After the three anis were marked and easy to recognize, and

had recovered from the excitement caused by the foreign object in the nest. I entered my blind to learn what share each would take in attending the eggs. I watched from 1335 until dusk fell at 1845 on 16 February, and next morning from daybreak at 0615 until 1241. Whiteface settled on the nest at 1708 on 16 February and remained sitting quietly while the sun set and the light waned. Next morning he continued to sit for about an hour and a half after early birds had become active, not leaving until he saw Whitebrow and Whitethroat approach together at 0745. Thus he had incubated continuously for 14 hours and 37 minutes. During the day, however, his two mates were in the nest far more than he. Whitethroat took three turns at incubation, sitting for 127, 49, then 94 minutes, making a total of 270 minutes. Whitebrow also sat thrice, for 1, 94, and 25 minutes, or a total of 120 minutes. Whiteface's three diurnal sessions lasted only 12, 4, and 23 minutes, a total of 39. The trio of anis had no regular system of alternation on the eggs, for any one might follow any other. Each did not always sit until the arrival of another to replace it, with the result that the eggs were left uncovered for periods of 3, 11, 24, and 7 minutes, a total of 45. They were, however, kept covered for 90.5 per cent of the slightly more than eight hours of my watch which fell within the period when the attendants were replacing each other on the nest—that is, during the time not included in Whiteface's long overnight shift.

Each of the three anis twice brought a green leaf when it came to take charge of the nest. Once Whiteface passed the leaf to Whitethroat, whom he had come to relieve. The latter carelessly placed it beside the eggs which she had been covering, then apparently with reluctance left the nest and flew away, calling, while Whiteface settled on the eggs. The other leaves were placed in the nest by the bird that brought them, sometimes carefully tucked beneath the eggs, sometimes negligently dropped down beside them. Once, while Whitethroat incubated, Whiteface and Whitebrow perched side by side in the top of the nest tree, and each in turn stretched up its neck with the feathers erected, while the other preened them. Whitethroat gave no indication of jealousy when Whiteface showed this delicate attention to his other mate. I never noticed a sign of rivalry or disagreement between these three birds.

One of the eggs which had been present when I first saw the nest on 7 February hatched on 24 February. The following day two more eggs hatched, including one which had been laid on 10 February. The incubation period of this last-mentioned egg was not over 15 days. The set had not been completed, however, until 13 February, and probably full-time incubation did not begin until this date, or even later. Unfortunately, the last egg, which would have given the most accurate determination of the incubation period, did not hatch. Only three of the nine eggs in the nest produced nestlings; and when



several more days passed and the others gave no sign of life, I opened them. None contained an embryo.

Davis (1940a) found the incubation period of the Smooth-billed Ani to be about 13 days. By changing eggs in a nest, he caused a group of three anis to continue incubation for 24 days—almost twice the normal period. Although he had under observation numerous nests containing from 10 to 29 eggs, in no instance did more than eight hatch, apparently because the others were not effectively warmed by the incubating birds, for he never found an infertile egg. Groove-billed Anis do not often lay more than eight eggs in a nest, and at one nest that contained eight, they hatched the entire set (Skutch, 1959).

*The nestlings.*—The newly hatched anis in the orange tree had tightly closed eyes and perfectly naked black skin; they lacked even the stiff, hair-like down worn by newly hatched cuckoos of the genus *Coccyzus*. Their development was amazingly rapid. On the day after hatching, the sheaths of the remiges and rectrices began to protrude from the skin. Two days after hatching, the sheaths of the contour feathers were also emerging from the skin and the eyes were open. The pinfeathers on wings, tail, and body became very long before they began to release the true feathers which they enclosed. When the young ani was five days old, its body feathers began to emerge from the tips of their sheaths. At this age it could hang by one foot from my finger, and pull itself up by using its feet and bill, which was hooked over the support. When placed on the ground, it tried to crawl away through the grass, and might have escaped if I had not been alert to catch it. When I replaced it in the nest, it would not stay down in the bowl, but persisted in climbing up to perch on the rim. It uttered a little whining note.

The following day, when the surviving nestling was six days old, it hopped from the nest as I came near and began to climb through the thorny branches of the orange tree, but it soon lost its hold and fell to the ground, where it tried to scramble away through the grass. When I took it in hand it struggled to escape, at the same time uttering an infantine version of the usual call of the adults; but I quieted it by stroking its back. Both the body and flight feathers had lengthened considerably since the preceding day and were now expanding rapidly; but much bare skin was still visible between them. I replaced the young ani in its nest and persuaded it to stay, at least until I was out of sight. The other nestlings had vanished within two or three days of hatching and this was the only survivor. The following day it, too, had disappeared from the nest. It was then a week old, fairly well clad in feathers, and sufficiently agile to take care of itself by clambering through dense vegetation. But I looked in vain for it, and at last reluctantly concluded that it no longer lived.

Whiteface, the male parent who had incubated the eggs during the night,



also brooded the nestlings through the hours of darkness. When I approached the nest, he became more excited than the two females and once, when the oldest nestling was two days of age, he alighted for a moment in the little nest tree while I was at the nest. He would also fly around quite close to me, voicing an angry *grrr*. Perching on a neighboring tree, he often uttered his high-pitched whining call, which was repeated by the two females, who consistently stayed farther away from me. When the nestling was a few days older, Whiteface did not venture quite so close to scold me, although all three parents still showed much concern whenever I visited the nest. In the more courageous conduct of the male when the nestling appeared to be in peril, these Smooth-billed Anis agreed with a pair of Groove-billed Anis whose sexes I could distinguish. But Whiteface never attempted to strike me when I went to his nest, as the Whiteface with the grooved bill for whom he was named had repeatedly done.

After the disappearance of the last nestling, Whiteface joined the two females at their roosting place, a low bush with dense foliage growing on the shore of the lake, about 100 yards from the nest tree. Here the anis slept in close company with Vermilion-crowned Flycatchers (*Myiozetetes similis*), Cayenne Flycatchers (*M. cayanensis*), and Tropical Kingbirds (*Tyrannus melancholicus*).

At a nest containing nine nestlings hatched from eggs which had apparently been laid by only two females, Davis (1940a:194) observed that nine of the 15 birds in the group were bringing food. He found that the fledglings return to the nest for the first two nights after their initial departure. A single parent sleeps with them for several nights after they have left the nest but still linger in the nest tree. After the young can fly, the adults take them out to the feeding area and the whole flock roosts there. The young are fed by the parents for about a month after leaving the nest. In Cuba, a single group of birds may raise three broods in a season. The young of earlier broods remain with the parents while they attend later broods and may feed the nestlings, although less actively than the adults. In one instance, juveniles only 48 days old helped to feed the following brood. The ani's instinct to build is likewise manifested at an early age: in Florida, a hand-reared young bird carried about sticks and straws and arranged them on the ground when only about six weeks old. This foundling Smooth-billed Ani made an attractive, responsive pet (Merritt, 1951).

*Laying and the identification of the sexes.*—The loss of all their offspring from the orange-tree nest was the first of a long series of misfortunes that befell Whiteface and his two mates. On 15 March, 12 days after the disappearance of the last nestling, I found the trio working on a new nest in a low, dense bush standing on the shore of the lake, between the first nest and their

roosting place. Two days later, the new nest contained an egg, which remained alone for two days and then vanished, on 20 March. On 28 March, I noticed their third nest, eight feet up in a small orange tree growing in the grassy clearing, a few yards from the bush that held the abandoned second nest. They apparently built this nest, or at least enough of it to hold an egg, in a single day; for on 24 March I had looked in this little tree and found no nest, but returning in the afternoon of the fourth succeeding day, I saw the completed structure with four fresh eggs which, to judge by the dates of laying of the subsequent eggs, must have been deposited on 25 and 27 March, two on each of these days.

It was at this nest that I succeeded in learning the sexes of these three anis in a manner which left no room for doubt yet left the birds alive for further activities and studies. I already knew that anis lay around midday, so at 1130 on 29 March I entered my blind to watch the laying of the eggs. The paint marks on Whiteface were still unmistakably conspicuous. Of the other two, one still bore a small but distinct white spot on the left wing which revealed her identity as Whitebrow. The third ani had lost all traces of white but was evidently Whitethroat. At 1230, Whitebrow entered the nest, which still contained the four eggs, each with an identifying mark. At 1233, she left as Whitethroat arrived to sit in the nest. The latter remained until 1258, and while she sat Whiteface brought and delivered to her a bit of weed stem, then a green leaf, both of which she arranged in the nest. When Whitethroat flew from the nest at 1258, Whitebrow returned to occupy it, remaining for 55 minutes while Whiteface brought her a green leaf, then a stick, then two more green leaves, all of which were duly added to the structure.

At 1353, Whitebrow ended her long session on the nest. Whiteface promptly flew toward it. But as it was of the utmost importance to see what the nest held before he had a chance to sit, I hurried from the blind and reached the nest ahead of him, finding two fresh, unmarked eggs that had been laid since 1230. Since Whitethroat and Whitebrow both laid eggs, some of which were fertile, Whiteface was undoubtedly the male of the trio. During the night of 30 to 31 March, he incubated the six eggs, and by 1255 next day two more had been laid, completing the set. By 7 April, only three of these eight eggs remained in the nest, and two days later all had vanished.

At the first nest of these anis, in the orange tree, one female had evidently laid seven eggs and the other six. At the nest where I watched the laying, each female produced four eggs. According to Davis (1940a:200), in Cuba each female lays from four to seven eggs in a set. At the first nest on Barro Colorado in 1935, an egg was laid between 1140 and 1340, and another was deposited before noon. At this nest, an egg was added daily during four days, and since two females were producing them, each apparently laid at two-day

intervals, as at the later nest; but in this case the two alternated with each other instead of both laying on the same day. The Groove-billed Ani also deposits its eggs in the middle of the day, at two- or three-day intervals (Skutch, 1959).

*Further history of the colony.*—For nearly a month after the loss of their eggs in early April, the three anis on Barro Colorado apparently suspended their efforts to rear a family. But on 6 May I found their fourth nest, already containing a single egg. It was in a clump of the marsh fern, *Acrostichum*, growing in swampy ground at the edge of the cove and about 50 feet from the third nest. On 7 May there were two eggs in the latest nest, but by 9 May it was empty.

During the next five days, the three anis must have been exceedingly busy. They started another nest in the orange tree that had held the first, but abandoned it after placing a few sticks. Next they took some sticks to another orange tree a few yards away, but this project of building was also given up at an early stage. Then they rapidly completed their fifth nest, in the midst of a dense clump of tall grass growing in shallow water along the shore, about 75 feet from the fourth nest. When found on 14 May, it already held three eggs, but three days later it was empty. Possibly a few more eggs had been laid in the interval.

A week later, on 24 May, these anis had a sixth nest in a lemon tree, 15 feet from the site of their first, and it already contained seven eggs. I had never learned what despoiled the anis' nests, but I believed it to be some flightless creature. Accordingly, in an effort to save this latest nest, I surrounded the base of the nest tree with a tall cylinder of sheet iron, setting the bottom firmly against the ground so that, I believed, no snake could force its way beneath it; and I doubted whether serpent, lizard, or small mammal could scale the slippery upright wall. While I was engaged in arranging the protective barrier around the lemon tree, *four* anis perched in a neighboring tree to watch me. The new arrival had apparently come from the mainland, possibly crossing to Barro Colorado at Salud Point, where only a narrow stretch of open water separated the island from Buena Vista Point on the mainland, thence working along the shore of the island to the laboratory clearing. At least, this route seemed more likely than that the new arrival flew across the mile or two of open water of Frijoles Bay, or that it crossed the wide expanse of unbroken forest that enclosed the clearing on the other three sides. The newcomer seemed already to have been accepted as a member of the group; and I hoped that with this increase in force and the protection that I had given them, their efforts to reproduce would at last be crowned with success. But on 28 May three whole eggs and at least three broken ones lay on the ground beneath the empty nest. A few days later, I left the island.

Between 1 February and 24 May, the three anis had built six nests and started several more which they did not complete. The two females (possibly with the help of another at the very end) had laid at least 34 eggs and possibly several more that vanished before I saw them. The intervals between the disappearance of the eggs from one nest and the first laying in the following nest were in some instances surprisingly short: about five days between the second and third nests; only three or four days between the fourth and fifth nests; evidently less between the fifth and sixth. Davis (1940a:192) found that laying was resumed in a new nest about five to 14 days after the loss of the eggs from an earlier nest.

*The Smooth-billed Ani in Costa Rica.*—Although the Pacific side of Central America, as of México, is generally semiarid, with a long and severe dry season that limits the development of the woodland, Costa Rica south of the Gulf of Nicoya is a region of higher rainfall and heavier forest, which over large areas rivaled the rain forest on the Caribbean side of the country in luxuriance. At the beginning of the present century, this southern Pacific quadrant of the country was sparsely inhabited by man, its few scattered settlements separated by long stretches of rough, muddy forest tracks. Colonists from the center of the country slowly trickled in, along the difficult trail that passed over the dreaded Cerro de la Muerte in the Talamancan Cordillera, or else by sea from Puntarenas. The settlement of this region, especially the basin of El General at the head of the valley of the Río Térraba, received a great impetus with the coming of commercial aviation in the early 1930's; while farther south, at about the same period, the development of the port of Golfito and of large banana plantations around Palmar Sur stimulated the settlement of the hinterland. The opening of the Inter-American Highway, from Cartago to San Isidro del General about 1946, and from San Isidro to the Panamanian border around 1963, brought this once remote region into easy communication with the center of Costa Rica and sealed the doom of its wilderness. Except on the higher and less accessible slopes of the Cordillera de Talamanca, the once magnificent forest is now a dwindling remnant that yearly shrinks before expanding farmlands of inferior agricultural value.

With the replacement of the forest by pastures, coffee plantations, and large areas devoted to the shifting cultivation of grains, far-reaching changes in the avifauna have occurred. That which now concerns us is the spread and increase of the Smooth-billed Ani. When I first arrived in El General late in 1935, the Groove-billed Ani (the common species throughout Central America) was sparingly present; but I found no Smooth-billed Ani until 1940, when on 12 March three or four were encountered in a pasture in the valley of the Río Pacuar, near the head of the Térraba Valley. A lone Groove-billed Ani,



isolated from others of its kind, tried for six weeks to join the Smooth-bills but was always repelled (Skutch, 1959:307-310).

This was eight years after the Smooth-billed Ani was first reported from Costa Rica by Austin Smith, who on 26 December 1931 found a small colony at the Río Coto, near the Panamanian border (Slud, 1964:126). However, the Smooth-bill may well have been present in this remote region, undetected by ornithologists, for many years before this date. Today, this appears to be the only ani present on the Pacific side of Costa Rica, between the lower reach of the Río Térraba and the Panamanian border, except for an isolated population of the Groove-bill on the Peninsula de Osa. During three months passed in the Palmar-Golfito district in 1947, I noticed only *Crotophaga ani*, and the same was true during a four months' sojourn in the Cañas Gordas-San Vito region in 1964. Slud (1964:126) likewise failed to find the Groove-billed Ani in this frontier zone of Costa Rica, where heavy rain forests are rapidly disappearing before too avid human settlement.

Since I first noticed the Smooth-billed Ani in El General in 1940, it has been increasing far more rapidly than the Groove-billed Ani. In the middle 1950's, the latter still seemed to be the more abundant species. Today, the reverse is certainly true. On several journeys afoot and on horseback early in 1964, I paid particular attention to the anis. Between 2,500 and 4,000 feet above sea level, I found many flocks of the Smooth-bill but only one of the Groove-bill. Why one species is flourishing so much better than the other is an unsolved problem. As far as I know, the two kinds of anis have quite similar requirements, but the Smooth-bill appears to be the more aggressive bird. Both species are sympatric over large areas in Colombia, Venezuela, and western Ecuador. Possibly in these countries they occupy different ecological niches, but the problem appears not to have been investigated.

At Palmar Sur, Costa Rica, on 18 September 1947, I found a nest of the Smooth-billed Ani with one fresh egg. On 30 July 1958, between El Quizarrá and Santa Elena, I found the first nest of the species in El General. By 1 August it contained its full complement of five eggs. When I examined it, five adults protested. Although in Central America anis of both species breed later than the majority of the birds, early nesting sometimes occurs. On 18 May 1964, near Cañas Gordas at 3,700 feet, I found a nest with four nestlings in pinfeathers. Even earlier nesting was indicated by the behavior of a group of about eight Smooth-billed Anis which I watched on our farm at about 2,400 feet on 9 April 1962. They were foraging on a field prepared for planting maize, where the ground was strewn with slender tree trunks, chopped up branches, and dry weeds. They walked rather than hopped along the horizontal trunks and over the ground rough with drying vegetation, rarely hopping from one branch to another. Sometimes an ani flew a short distance in pursuit



of a grasshopper that tried to escape by flight, and usually it captured the fugitive. Grasshoppers were evidently their principal prey. After catching a large one, they would beat and bite the life out of it, then carry it eastward across the Río Peña Blanca to a pasture overgrown by a tangle of weeds, bushes, and vines, in the midst of which they evidently had a nest, or fledglings still unable to follow their parents. Their destination was 600 feet or more from the field where they foraged, and they made this considerable journey in characteristic ani fashion, breaking it into several stages, and often pausing to rest in the riverside trees before continuing on their way.

#### SUMMARY

The Squirrel Cuckoo is found from the lowlands up to 7,000 or 8,000 feet but is more abundant at lower altitudes. Avoiding the interior of the forest, it inhabits open and cultivated country with scattered trees in both wet and semiarid regions. It lives in pairs throughout the year.

Its diet consists of adult and larval insects, including caterpillars covered with stinging hairs.

Its varied calls are described.

Males feed their mates, and both retain their hold on the article of food during coition.

Nests are placed in trees or in low tangled growth. While building, one partner (probably the male) brings material to the other, who stays on the nest and arranges it. One pair tried for over a week to build in an inadequate site from which all their material fell to the ground. They worked most actively after the middle of the morning. The completed nest consists of a loose foundation of coarse sticks supporting a thick mass of leaves, some of which are green when brought.

In southern Costa Rica, the breeding season extends from January to October and appears to be at its height from April to June. The white, chalky eggs, usually two in a set, are soon stained with brown by contact with the leaves on which they rest.

Both parents incubate. After the routine of incubation was well established, one pair kept their eggs constantly covered, changing places only twice a day. One partner sat through the middle of the day, for seven or eight hours continuously, and the other all the rest of each 24-hour period.

The nestlings hatch with hair-like down feathers. At all stages they are fed infrequently—only four or five times in a morning for a single feathered nestling—but from the first the meals are substantial. Each meal consists of a single larval or winged insect, which is usually quite massive, and badly mangled when brought to the nest. Nestlings receive caterpillars with stinging spines.

The parents carry droppings from the nest, which nevertheless becomes somewhat soiled.

Even after they are well feathered, nestlings are brooded through the night, in the early morning and late afternoon, and when rain falls. Their separation from the nest is a gradual process, and they spend several days hopping through, and resting in, the surrounding branches.

The Lesser Ground-Cuckoo, confined to the Arid Tropical Zone of México and Central America, walks over the ground in search of food. Its calls include full, mellow whistles and trilled whistles.

In mid-July, in the Motagua Valley of Guatemala, a nest was found on the ground, beneath a bush. The open bowl of petioles and sticks, lined with fine herbaceous materials, held two white eggs with a chalky surface.

Both parents incubated, sitting for  $2\frac{1}{2}$  to  $3\frac{1}{2}$  hours continuously. After permitting a very close approach by a man, they gave a variety of distraction displays, although not the "broken-wing" ruse.

An isolated colony of three Smooth-billed Anis on Barro Colorado Island, Panamá Canal Zone, was kept under observation for nearly four months. The group consisted of a male and two females, identified by marking them with paint and watching them lay.

The two females laid in the same nest, depositing their eggs around midday. Each female laid four to seven eggs in a set. The male regularly incubated by night, and by day all three parents (but chiefly the females) took turns on the eggs, sitting from 1 to 127 minutes at a stretch. There were short intervals of neglect, but the eggs were kept covered for 90.5 per cent of the period when the three were taking turns on the nest. While incubation was in progress, fresh green leaves were brought to the nest.

Hatched without a trace of down, the nestlings developed rapidly, and if disturbed crawled from the nest when only five or six days old. The male brooded by night and protested more vehemently than the females when the nest was visited.

During four months, this group of anis built at least six nests, and the two females laid at least 34 eggs, without rearing a single fledgling. The despoiler of their nests was not discovered. The interval between the disappearance of the eggs from one nest and the first laying in the following nest was in several cases only three to five days, and once apparently even less.

The Smooth-billed Ani was first recorded in Costa Rica, near the Panamanian border, in 1931. By 1940 it had reached the upper Térraba Valley, where the Groove-billed Ani was already resident in small numbers. Since that date, the Smooth-bill has become much more numerous than the Groove-bill in this region.

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EL QUIZARRÁ, SAN ISIDRO DEL GENERAL, COSTA RICA, 14 JUNE 1965